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Turbulence closure modeling with Machine-Learning Methods: Can RANS overcome curse of averaging? SHARATH GIRIMAJI, Texas AM University — Reynolds-averaged Navier-Stokes method (RANS) is the most commonly used turbulence closure model in engineering applications due its inherent simplicity and reasonable predictive capability in elementary flows. However, RANS models are restricted in their applicability as many complicating influences cannot be adequately accounted for at this level of turbulence closure. In recent years, data-driven methods, specifically machine learning (ML) procedures, have been used to enhance the capability of RANS to complex flows. At this stage of development, the extent to which ML can help RANS models overcome its inherent inadequacies is unclear. In this work, we demonstrate that averaging the governing equations over all scales of motions renders the RANS method intrinsically inadequate in many aspects. This 'curse' of averaging is due to the fact that many critical physical processes occurring in the fluctuating fields cannot be accurately represented in terms of low-order statistics. We investigate the types of physical effects that cannot be captured within the RANS-paradigm even with the best data-driven procedures. It is expected that the findings can help better understand the limitations of ML-turbulence models and temper expectations.

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